



A STRUCTURE AND FABRICATING METHOD OF OPTIC PROTECTION FILM

1. Field of the Invention

The invention relates to a structure and a method for fabricating an optic protection film that provides anti-static and anti-glare function. In particular, the invention relates to a plastic substrate structure comprising conductive particles and tiny particles in different size so as to achieve the foregoing functions.

2. Background of the Invention

Glass substrate or transparent plastic substrate is one of the essential elements in a flat display, and the transparent plastic substrate surpasses the glass substrate by having a lighter weight and being difficult to blowout. The plastic substrate has its weakness, such as adsorbing dust easily because of static electricity. To use a liquid crystal display as an example, a traditional Simple Matrix liquid crystal display (SM-LCD), whose structure is shown in FIG. 1 comprises (from top to bottom) a hard coating layer 13, a conductive layer 12, a protection film 11, a polaroid 10, a glass substrate 30, a row electrode 50, a liquid crystal layer 80, a column electrode 60, a dichroic filter 70, a glass substrate 40, a polarizing filter 20, a protection film 21, a conductive layer 22, a hard coating layer 23. FIG. 1 shows that the liquid crystal molecule is located between the row electrode 50 and the column electrode 60 and is driven to turn by the exteriorly provided driving voltage. But some problems may be occurred in SM-LCD such as (1) cross-talk accomplished with an increased accumulation of scan electron (2) charges, electro field interference, and liquid crystal operating issue that happens in the top and bottom polaroids. So in the manufacturing process of polaroid, protection film and release film will be pasted in both top and bottom sides respectively. The function of the protection film is to protect the film surface of the polarizing filter, avoiding damage in the manufacturing or delivering. And the release film is used to carry on the sticking protection before panels are plastered. When the protection film is being torn, the film surface will accumulate static electricity because of rub, and then the

remaining static electricity will attract the foreign body. On the other hand, when release film is being torn in manufacturing process, it will also produce the static electricity accumulation, which will not only attract the foreign body but also result in deviation in the matching process of panel plastering, which effects the process yield. Therefore, the anti-static anti-glare film (ASAG film) is designed to solve these issues. The ASAG film on the whole contains three layer constructed as previously described, which are a hard coating layer 13, a conductive layer 12, and a protection film 11.

In the anti-static technology, sputtering method also can be used to form conductive layers. It can produce more uniform grain size particles, better adhesion with substrate, and better optic character. But because the process requires a vacuum camber, there are still disadvantages including very high equipment cost, a film of raw material is not easy to operate in the vacuum chamber. There is another way to form the conductive layer that uses the wet coating method, which is a two-layer coating method enclosed by Dai Nippon Printing Co., as shown in US patent 6,146,753, forming a transparent conductive layer and a hard coating layer successively on the transparent protection film (abbreviated as "plastic substrate" hereafter). Wherein the conductive layer contains conductive particles of antimony Tin oxide (ATO) or indium Tin oxide (ITO); its surface impedance is $\leq 10^8 \Omega/\square$ and can reduce the electrostatic generation. The increased conductive layer can reduce the surface impedance to a range between $10^6 \Omega/\square$ and $10^7 \Omega/\square$, so as to prevent a great deal of static electricity being created. Because of the consideration of transmittance, generally the thickness is about $5\mu\text{m}$. The conductive layer is not hard enough, and easily falls off when colliding, so it needs a coat of hardened resin for strength. Moreover, because the hardened resin has no electric conductivity, conductive particles must be added to extend the conductivity and remove the accumulation charges. However the conductive metal particles are very expensive, which greatly raises the coating cost and makes manufacturing more difficult.

The hard coating layer is coated with the mixture of hardened resin and conductive metal particles; the hardened resin provides the basic requirement of harness, and the conductive metal particles provide the electric conductivity between

the coated surface and the conductive layer. If the thin film wants to increase the anti-glare function, the hard coating layer can be added with nano-level tiny particles, which can scatter the incident light to provide the anti-glare function.

5 The present invention is to provide a plastic substrate with an optic protection film with anti-static and anti-glare function, solving the foregoing fabrication issues.

SUMMARY OF THE INVENTION

The major objective of the present invention is to provide a fabrication method of an optic protection film, which has some conductive particles to provide an anti-static function when forming the conductive layer onto the plastic substrate.

10 Another object of the present invention is to provide a fabrication method of an optic protection film, which includes some tiny particles so as to produce an anti-glare function when forming the conductive layer onto the plastic substrate.

The other objective of the present invention is to provide a structure of an optic protection film, which has better hardness and better adhesion.

15 First, a plastic substrate, the material of which is Cellulose Triacetate or polyester, is selected, and then a conductive layer is formed on the plastic substrate. The conductive layer is a double-layer resin film structure made of two different kinds of resins. In the beginning, some conductive particles, which have two different grain sizes, are melted into resin A to enhance the conductive effect of resin
20 A. The resin A containing the conductive particles is coated on the substrate by wet coating method. Then most of an alcohol in resin A is evaporated in the hot bake step so as to fasten the resin A; the thickness of resin A is less than a bigger grain size of the conductive particles in resin A after hot bake. And the polymer in resin A can process polymerization to strengthen the structure by a thermosetting or an
25 ultraviolet light curing method. Next, some smaller SiO₂ particles are added into resin B that has a better hardness to attain the anti-glare function. The resin B containing tiny particles is coated on the resin A and fills all the gaps between the conductive particles. Then resin B is strengthened in the hot bake and the thermosetting or the ultraviolet curing step. At this time, because the grain size of
30 the conductive particles are larger, at least the upper periphery of the bigger

conductive particles either touch or are exposed through an upper surface of resin B so as to prevent charges accumulating in resin B and to attain the anti-static effect. Thus, the optic protection film with anti-static and anti-glare function is accomplished.

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BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 is a sectional view of the traditional SM-LCD.

Fig. 2A is a sectional view of the plastic substrate according to the embodiment of the present invention.

Fig. 2B is a sectional view of the conductive particles according to the embodiment of the present invention.

Fig. 2C is a sectional view of the conductive layer with anti-glare function according to the embodiment of the present invention.

DETAILED DESCRIPTION OF THE INVENTION

The present invention is a structure and method of fabricating an optical protective film providing an electricity conductivity and anti-static functions by adding at least two kinds of different size conductive particles, including bigger conductive particles and smaller conductive particles are added into resin A that is the conductive layer. A thickness of a solidified resin A is larger than the grain size of the conductive particles with a smaller grain size, but less than that of the conductive particles with a bigger grain size. Resin B is composed of a relatively high hardness material, coated on resin A to be a hard coating layer. Moreover, in the foregoing conductive particles of bigger grain size, at least an upper periphery of partial bigger conductive particles either touch or are exposed through an exterior of an upper surface of resin B and contacting the external environment. Therefore, resin B need not have conductive metal particles because the charges of resin A can be released to the exterior, avoiding charges accumulating in resin B. Resin A provides the anti-static function, simplifies the fabrication process, and reduces the cost.

Fig. 2A shows a plastic substrate 100, the material of which can be cellulose, diacetate, triacetate, cellulose acetate butyrate, polyester, polyamide, polyimide, polyether sulfone, polysulfone, polypropylene, polymethylpentene, polyvinyl chloride, polyvinyl acetal, polyether ketone, methyl polymethacrylate, polymethymethacrylate (PMMA), polycarbonate, and polyurethane. The better material is cellulose triacetate (TAC) and polyethylene (PE). TAC or PE is a familiar substrate material available in commerce, for exemplar Fuji or Konica etc. all provide such a substrate.

The key point of the present invention is to form a conductive layer 200 on the plastic substrate 100. The conductive layer 200 is a double-layer structure including: a thin film layer on resin A containing conductive particles to provide better conductivity, and a thin film layer of resin B that is relatively harder and can be a hard coat layer. The formation of this conductive layer 200 is divided into two steps: depositing or coating conductive particles 200 and resin A on substrate 100. Then forming tiny particles 230 and resin B onto the foregoing. The detail embodiment steps are described below. As shown in Fig. 2B, firstly, the conductive particles 220, which are mainly composed of 1-Butanol, Ethanol, Ethyl acetate (EAC), Hexane, isopropanol (IPA) 80%, and partial acrylic resin, are mixed into Resin A which has a solid content of 5% to 25% by weight. The weight percentage of conductive particles 200 to resin A is 50% to 30% by weight, and the conductive particles 200 have two sizes: a bigger grain size (the diameter is $0.5\mu\text{m}$ - $7\mu\text{m}$) and a smaller grain size (the diameter is $0.1\mu\text{m}$ - $0.5\mu\text{m}$). The conductive particles of the bigger grain size accounts for 0.5% to 10% of the conductive particles 200 and the conductive particles of small grain size account for 90% to 99.5% by weight. The conductive particles 200 can be composed of antimony tin oxide (ATP) or indium-tin oxide (ITO). The resin A that contains at least two kinds conductive particles 220 of different grain size is coated on the substrate 100 to form a $5\mu\text{m}$ thin film by wet coating method; wherein the method of wet coating can be spin coating, roll coating, gravure coating, bar coating, and slot die coating etc. As shown in Fig. 2B, the resin A of the embodiment in the present invention will become thinner after the solidification steps of hot bake and ultraviolet light curing, and thus will not cover all the conductive particles. Relatively, the thickness of resin A after the solidification

processing is larger than the conductive particles of smaller grain size but less than the conductive particles of bigger grain size, making all the bigger grain size conductive particles protrude from at least some portions of an exterior of an upper surface of the solidification resin A layer (as shown in Fig. 2B). The conductive particles 220 composed of ATO (or ITO) are used as the conductive elements of conductive layer in the traditional structure. In addition to adding ATO (or ITO) particles of the original grain size ($0.1\mu\text{m}$ to $0.5\mu\text{m}$), like traditional fabrication process, the present invention adds some extra ATO (or ITO) particles of bigger grain size ($0.5\mu\text{m}$ to $7\mu\text{m}$). To maintain the original conductivity, the present invention uses the ATO particles of bigger grain size to fill and bridge vertically between resin A and resin B, wherein the resin B has the anti-static function without adding any conductive particles. This method can prevent the drawback in the prior art that extra conductive metal particles need to be added into hard coating layer to avoid the charge accumulation, and can reduce the difficulty of fabrication process and cost.

Further, during the thermal curing process the resin A is solidified, and most of the alcohol in the resin A is evaporated during the hot bake step so as to fasten resin A to the substrate 100. The temperature of hot bake is 50°C to 90°C , and the hot bake time is about 0.5min to 5 min. The temperature of the hot bake depends on the kind of solvent being used in resin A, and needs to be lower than the boiling point of the solvent. In this embodiment, the solvent can be isopropanol, so the temperature of the hot bake is about 60°C . Next, ultraviolet light is used to make the polymer in resin A proceed to polymerization of a cross-link to strengthen the structure; wherein, the intensity of ultraviolet light is $150\text{mJ}/\text{cm}^2$ to $100\text{mJ}/\text{cm}^2$, and the thickness of the resin A after solidified is $0.5\mu\text{m}$ to $2\mu\text{m}$.

Further, 1wt% to 3wt% silicon oxide (silica) tiny particles 230, in nano level, are added into resin B and stirred by a homogenizer; the grain size of silica tiny particles 230 is $0.1\mu\text{m}$ to $1.0\mu\text{m}$. The solid content of the resin B is 45% to 50% by weight, and its major content is acrylic resin; after the solidification process, resin B can have a predetermined hardness and thus be used as a hard coating layer. The silica tiny particles 230 will cluster upward in the process of solidification and the

resin B coating because of their buoyancy. So when incident light is entering, the tiny particles, which are in the surface of the most outer layer (resin B layer), can scatter the incident light to irregular directions and attain the anti-glare effect. The resin B containing tiny particles 230 is formed onto the resin A by wet coating method and fills all gaps between conductive particles 220 to form a film, preferably a 10 μ m thin film. The tiny particles 230 will float in the surface of the resin B because of their buoyancy to exert the anti-glare function. Wherein, the wet coating method can be the same as or different to the coating method of resin A. Next step is solidification, which evaporates most of a solvent in the resin B to fasten the resin B by a hot make method. The temperature of the hot bake is 50°C to 95°C and the process time is 0.5min to 5.0 min. Then ultraviolet light is used to make the polymer in resin B proceed to polymerization of a cross-link so as to strengthen the structure; wherein, the intensity of ultraviolet light is 150mJ/cm² to 1000mJ/cm², and the thickness of resin B after solidified is 4 μ m to 5 μ m.

Thus the conductive layer 200 of such formation will have the function of a hard coating protection, anti-static, and anti-glare, etc., and the conductive particles 220 make conductive layer 200, whether the resin A film or the resin B film, possesses the static electricity removing function. The hardness of resin B is high enough to protect conductive layer 200 and substrate 100, and can provide the effect of hard coating layer in tradition fabrication. Moreover, the present invention can be applied to the surface of an optic film of flat panel displays (such as LCD, PDA, PDP, NOTE-PC, CRT etc.). The anti-glare and anti-static functions of this optic film can satisfy the requirement of LCD panel manufacturers who demand the anti-static raw material, and can reduce the dust absorbing in flat panel displays to increase the comfort of users.

In summary, the present invention is to add at least two kinds conductive particles of different grain size into the resin A. Wherein the grain size of the bigger conductive particles is not only larger than the thickness of the resin A after solidified but even also equal to or larger than the total thickness of resin A and resin B after solidified. At least the outer periphery of the bigger conductive particles either touch or are exposed through the exterior of the upper surface of the resin B, containing

the external environment. So the resin B used as the hard coating layer will not need to add conductive material particles, but the charges in the resin A film are still removed to the external environment, avoiding charge accumulating in the resin B and attaining the anti-static function. Therefore, compared with the prior arts (such as US patent 6,146,753), which adds conductive particles in hard coating layer and thus result in the increasing of cost and the difficulty of fabrication, the present invention can simplify the fabrication process and reduce the cost.

However, the above description is only the preferable embodiment of the invention and cannot be used as a limitation for the scope of implementation of the invention. Any variation and modification made from the scopes claimed from the invention all should be included within the scope of the present invention.